DEPARTMENT OF CHEMISTRY

UG - SYLLABUS

(*Effective for the batch of candidates admitted in 2016-2019 and thereafter*)

GURU NANAK COLLEGE
(AUTONOMOUS)
(Reaccredited at 'A' by NAAC)
VELACHERY,
CHENNAI – 42

CONTENTS

GURU NANAK COLLEGE (AUTONOMOUS)
VELACHERY, CHENNAI – 42.

B.Sc., DEGREE COURSE IN CHEMISTRY

S. No	Course Component	Name of the course	Semester	Hours	Credits	Max. Marks		
						Ext. mark	Int. mark	Total
I SEMESTER								
1	PART - I	Language	I	6	3	50	50	100
2	PART - II	English	I	6	3	50	50	100
3	Core – 1	Basic Chemistry - I	I	5	4	50	50	100
4	Core Practical - I	Volumetric Analysis and Inorganic Preparations	I	3	*	*	*	*
5	Allied - I	Mathematics - I	I	8	5	50	50	100
6	NME	Non Major Elective – I**	I	2	2	50	50	100
7	Soft Skill		I		3	50	50	100
II SEMESTER								
8	PART - I	Language - II	II	6	3	50	50	100
9	PART - II	English - II	II	6	3	50	50	100
10	Core Theory - 2	Basic Chemistry - II	II	5	4	50	50	100
11	Core Practical - I	Volumetric Analysis and Inorganic Preparation	II	3	3	50	50	100
12	Allied - II	Mathematics - II	II	8	5	50	50	100
13	NME	Non Major Elective- II**	II	2	2	50	50	100
14	Soft Skill		II		3	50	50	100
III SEMESTER								
15	PART - I	Language – III	III	6	3	50	50	100
16	PART - II	English – III	III	6	3	50	50	100
17	Core Theory - 3	Organo-Oxygen Compounds	III	6	4	50	50	100
18	Core Practical - 2	Inorganic Qualitative Analysis	III	3	*	*	*	*
19	Allied –II	Physics - I	III	6	3	50	50	100
20	Allied Practical	Allied Physics Practical - I	III	3	*	*	*	*
21	Soft Skill		III		3	50	50	100

IV SEMESTER								
22	PART - I	Language – IV	IV	6	3	50	50	100
23	PART - II	English – III	IV	6	3	50	50	100
24	Core Theory - 4	Chemistry of s and p Block Elements	IV	5	4	50	50	100
25	Core Practical- 2	Inorganic Qualitative Analysis	IV	3	3	50	50	100
26	Allied - II	Physics – II	IV	5	3	50	50	100
27	Allied Practical	Allied Physics Practical – I	IV	3	4	50	50	100
28		EVS	IV	2	2	50	50	100
29	Soft Skill		IV		3	50	50	100
V SEMESTER								
30	Core Theory - 5	Organo Nitrogen Compounds and Natural Products	V	4	4	50	50	100
31	Core Theory - 6	Chemical Kinetics and Electrochemistry	V	4	4	50	50	100
32	Core Theory - 7	Special topics in Chemistry	V	4	4	50	50	100
33	Core Theory - 8	Analytical Chemistry - I	V	4	4	50	50	100
34	Core Practical- 3	Gravimetric Analysis	V	5	*	*	*	*
35	Core Practical - 4	Analysis and Preparation of Organic Compounds	V	2	*	*	*	*
36	Core Practical - 5	Physical Chemistry Practical	V	3	*	*	*	*
37	Elective - 1	Elective – I***	V	4	5	50	50	100
38		Value Education	V		2	50	50	100
VI SEMESTER								
39	Core Theory - 9	Thermodynamics and solutions	VI	5	4	50	50	100
40	Core Theory- 10	Chemistry of d & f block elements and Coordination chemistry	VI	5	4	50	50	100
41	Core Theory- 11	Analytical Chemistry - II	VI	5	4	50	50	100
42	Elective – 2	Elective – II***	VI	5	5	50	50	100
43	Elective - 3	Elective – III***	VI	4	5	50	50	100
44	Core Practical - 3	Gravimetric Analysis	V	5	4	50	50	
45	Core Practical - 4	Analysis and preparations of Organic Compounds	VI	3	3	50	50	100
46	Core Practical- 5	Physical Chemistry Practical	VI	3	3	50	50	100
47		Extension activities	VI		1			
		TOTAL		**140**				

* The Practical Examinations will be conducted at the end of even semester.

** The Students must choose one NME paper in semester – I and one NME paper in semester – II.

*** The student must choose one Elective paper in Semester – V and Two Elective papers in Semester - VI from the list of offered electives.

CORE THEORY - 1: BASIC CHEMISTRY–I

SEMESTER I	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

Introduction to fundamental concepts of Physical, Organic and Inorganic Chemistry.

UNIT - 1: Atomic Structure (10 hrs)

Rutherford's atomic model. Bohr's theory of Hydrogen atom - Postulates, Bohr's radius, energy of hydrogen like species - Planck's quantum theory - Photoelectric effect - Compton effect. Hydrogen atomic spectrum - Particle and wave nature of electron - deBroglie equation - Heisenberg's uncertainty principle.

Quantum mechanical postulates, Operators - addition, subtraction, multiplication, linear, Hermitian, Commutator, Vector, Laplacian and Hamiltonian. Schrodinger's wave equation (Derivation not required). Significance of Ψ and Ψ^2.Wave mechanical concept of atomic orbitals - Shapes of orbitals - Quantum numbers. Zeeman effect.

Pauli's exclusion principle, Hund's rule - its basis and applications.

UNIT - 2: Periodic Classification and Periodicity in Properties (10 hrs)

Aufbau principle, Effective nuclear charge, screening effect, Slater's rule - applications and limitations. Electronic configuration of elements. Extra stability of half - filled and completely filled atomic orbitals.

Classification of elements - s, p, d and f block elements. Modern periodic table - position of hydrogen in the periodic table. Periodicity of the following properties - atomic radius, ionic radius, ionization potential, electron affinity and electro negativity, horizontal, vertical and diagonal relationships in the periodic table.

Scales of electronegativity - Pauling, Mullikan and Allred - Rochow.

UNIT - 3: Chemical Bonding (15 hrs)

Types of bond - ionic Bond – factors influencing the formation of ionic compounds - ionization energy, electron affinity and lattice energy. Determination of lattice energy - Born - Haber cycle, Inert pair effect, Fajan's rule

Covalent bond – polarity of covalent bond, percentage ionic character of covalent bond, dipole moment. Molecular structures of CO_2, H_2O, NH_3 and CH_4. Bond characteristics - bond length, bond strength, bond angle and bond energy.

Valence Bond theory – sigma (σ) and pi (π) bonds. Hybridisation, Valence shell electron pair repulsion theory (VSEPR) and geometries of molecules – $BeCl_2$, H_2O, BF_3, NH_3, XeF_4, XeF_4, BrF_3, PCl_5, SF_6 and IF_7.

Molecular Orbital Theory - Bonding and antibonding orbitals, bond order, applications of MO theory to H_2, He_2, N_2, O_2, O^{2+}, O^{2-}, HF and CO. Comparison between VBT and MO theory - Hydrogen bonding – types and consequences.

UNIT - 4: Nomenclature of Organic Compounds and Isomerism (10 hrs)

Nomenclature of organic compounds: IUPAC system of nomenclature of organic compounds – mono and bifunctional compounds.

Hybridisation and shapes of molecules - methane, ethane, ethylene, acetylene and benzene. Structural isomerism: chain isomerism, position isomerism, functional isomerism, metamerism and tautomerism.

UNIT - 5: Electronic Effects, Types of Reactions, Types of Intermediates (15 hrs)

Organic reactions – types (Substitution, Elimination, Addition, Rearrangement) with examples. Electron displacement effects - inductive, electromeric, mesomeric, resonance, hyperconjugation, steric effect and their applications (acid, base strength and dipole moment)

Cleavage of bonds – homolytic and heterolytic fissions. Reactive intermediates - carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes - their formation and stability.

TEXT BOOKS:

1. Arun Bahl and B. S. Bahl, Advanced organic chemistry, New Delhi, S. Chand & Company Pvt. Ltd, second edition, 2006.
2. M. K. Jain, S. C. Sharma, Modern organic chemistry, Vishal Publishing Co., fourth edition, 2003.
3. S. M. Mukherji, and S. P. Singh. Reaction Mechanism in Organic Chemistry Macmillan India Ltd, third edition, 1994.
4. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, New Delhi, thirtieth edition, 2009.
5. P. L. Soni and Mohan Katyal. Textbook of Inorganic Chemistry, Sultan Chand & Sons, twentieth edition, 2006.

REFERENCE BOOKS:

1. J.E.Huheey, E.A. Kieter and R.L. Keiter, Inorganic Chemistry, Harper Collins, NewYork, fourth edition,1993.
2. D.F. Shriver and P. W. Atkins, Inorganic Chemistry, W. H. Freeman and Co, London, fifth edition, 2010.
3. R. T. Morrison and R. N. Boyd, Organic Chemistry, Printice - Hall of India Limited, New Delhi, sixth edition,1992.

CORE THEORY –2: **BASIC CHEMISTRY–II**

SEMESTER II	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To provide knowledge on fundamentals of chemistry.

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UNIT –1: Nuclear chemistry (15 hrs)

Fundamental particles of the nucleus - nucleon - terminology, nucleides, isotope, isobars, isotones, mirror nuclei, nuclear radius, nuclear mass and nuclear forces operating between the nucleons. N/P ratio, curves, stability belts. Nuclear binding energy, Mass defect, simple calculations involving mass defect and B.E per nucleon. Shell model - Magic numbers - liquid drop model.

Radioactivity - group displacement law, natural radioactivity – radioactive series including neptunium series. Artificial radioactivity – induced radioactivity – uses of radio isotopes. Nuclear fission – Nuclear energy - Nuclear reactors – Breeder reactor – Nuclear fusion.

UNIT –2: Solid State (10 hrs)

Classification of solids, isotropic and anisotropic crystals, elements of symmetry, crystal systems, space lattices - bravais lattice, designation of planes, Miller indices, unit cell

Packing of ions in crystals (CCP, BCC and HCP).X - ray diffraction – derivation of Bragg's equation, Discussion of structures of NaCl, CsCl and ZnS. Determination of Avogadro's number, Problems related to solid state chemistry. Defects in crystals - Frenkel and Schotky defects.

UNIT –3: Hydrocarbons (10 hrs)

Alkanes – mechanism of free radical substitution in alkanes. Cycloalkanes - general methods of preparation (Wurtz's reaction, Dieckmann's reaction) – Bayer's strain theory and theory of stainless rings.

Alkenes - preparation and properties – Electrophilic and free radical addition - Orientation of addition reaction (Markovnikov's and peroxide effect) – addition reaction with H_2, X_2, H_2O , HX, HOBr and H_2SO_4. oxidation, ozonolysis and hydroboration. Hydroxylation with $KMnO_4$, OsO_4, allylic substitution by NBS.

Diene – Classification – stability and reactivity of 1, 2 and 1, 4 - addition. Synthesis of diene - 1, 3 - butadiene, isoprene and chloroprene.

Alkynes – preparation and properties – acidity of alkynes, formation of acetylides, addition reaction with H_2, X_2, H_2O with $HgSO_4$, oxidation, ozonolysis and hydroboration.

Polynuclear hydrocarbons – naphthalene, anthracene and phenanthrene - isolation, properties, synthesis and uses – carcinogenicity.

UNIT –4: Principles of Quantitative and Qualitative Analysis (10 hrs)

Volumetric analysis – Principles involved in Acid - base, Precipitation, Complexometric and Redox titrations – indicators and their choice. Definition and calculation of molality, normality, molarity and molefraction. Definition and examples of primary and secondary standard. Calculation of equivalent weights of acid, base, salt, metal and oxidizing and reducing agent.

Qualitative analysis – theory behind separation of groups - solubility product - common ion effect.Interfering anions and their removal. Brown ring test, Nessler's reagent, Prussian blue. Detection of phosphate, borate, fluoride, oxalate and chloride.

UNIT – 5: Organo Halogen Compounds (15 hrs)

Nomenclature and classification – Preparation and properties of alkyl halide – Mechanisms of nucleophilic substitution and elimination reactions of alkyl halide (SN^1, SN^2, SN^i, E_1, E_2, E_1CB) - Reactivity of alkyl, vinyl, allyl, benzyl halide towards substitution and elimination reaction – coupling reaction - Wurtz reaction – Ullman reaction .

Dihalogen compounds – Geminal dihalide – Vicinal dihalide – preparation and chemical reaction – poly halogen compound – BHC, DDT, Haloform, carbon tetrachloride, freons – Unsaturated halides – Vinyl halides – Allyl halides.

Preparation and properties of aryl halides – reactivity of vinyl halide vs. aryl halide - aromatic halogen compounds and their harmful effects to animal/humans. Comparison between alkyl and aryl halide.

TEXT BOOKS:

1. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing, fourth reprint, 2003.
2. S.M. Mukherji, and S.P. Singh. Reaction Mechanism in Organic Chemistry, Macmillan India Ltd., third edition, 1994.
3. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, New Delhi, thirtieth edition, 2009.
4. J.D. Lee, Concise Inorganic Chemistry, Blackwell Science, fifth edition, 2005.
5. P.L. Soni, and Mohan Katyal. Textbook of Inorganic Chemistry, Sultan Chand & Sons, twentieth edition, 2006.

REFERENCE BOOKS :

1. Arun Bahl and B.S. Bahl, Advanced organic chemistry, New Delhi, S.Chand& Company Pvt. Ltd., Multicolour edition, 2012.
2. T.W. Graham Solomons, Organic Chemistry, John Wiley & Sons, eleventh edition, 2012.
3. R.T. Morrison, and R.N. Boyd. Organic Chemistry, Pearson Education, Asia, sixth edition, 2002.
4. O.P. Agarwal, Organic Chemistry Reactions and Reagents, Goel Publishing house, 2005.

CORE PRACTICAL – 1: VOLUMETRIC ANALYSIS AND INORGANIC PREPARATION

SEMESTER I& II	SUBJECT CODE:	PRACTICAL	MARKS 100	CREDITS 3	HOURS 45

Objectives:

To expertise the practical skill in the quantitative chemical analysis and chemical preparations.

A) Volumetric Analysis

1. Estimation of HCl by NaOH using standard oxalic acid solution.
2. Estimation of Na_2CO_3 by HCl using standard Na_2CO_3 solution.
3. Estimation of oxalic acid by $KMnO_4$ using standard oxalic acid solutions.
4. Estimation of Fe (II) sulphate by $KMnO_4$ using standard Mohr's salt solution.
5. Estimation of $KMnO_4$ by thio using standard $K_2Cr_2O_7$ solution.
6. Estimation of Fe (II) by $K_2Cr_2O_7$ solution using standard Fe(II) solution.
7. Estimation of Cu(II) sulphate using standard $K_2Cr_2O_7$solution.
8. Estimation ofMg(II) by EDTA.
9. Estimation of total hardness of water.
10. Analysis of mixture of carbonate and bicarbonate.
11. Estimation of Vitamin C in fruit juices.

B) Preparation of Inorganic Complexes

1. Ferrous ammonium sulphate
2. Tetraamminecopper(II) sulphate
3. Microcosmic salt
4. Prussian Blue
5. Hexaamminenickel(II) chloride

1. A.L. Vogel, Text book of Inorganic Quantitative Analysis, ELBS, third edition, 1976.
2. G.S.Vehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, fifth edition, Revised, 1979.

NON - MAJOR ELECTIVE: DAIRY CHEMISTRY

SEMESTER I&II	SUBJECT CODE:	NON-MAJOR ELECTIVE	MARKS 100	CREDITS 2	HOURS 30

Objectives:

To learn the chemistry of milk and milk products and also the processes involved in the preservation and formation of milk products.

UNIT - 1: Composition of Milk

Milk - definition - general composition of milk - constitutents of milk - lipids, proteins, carbohydrates, vitamins and minerals - physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity - Factors affecting the composition of milk - adulterants, preservatives with neutralizer - examples and their detection - estimation of fat, acidity and total solids in milk.

UNIT - 2: Processing of Milk

Microbiology of milk - destruction of micro - organisms in milk, physico - chemical changes taking place in milk due to processing - boiling, pasteurization - types of pasteurization - Bottle, Batch and HTST (High Temperature Short Time) - Vacuum pasteurization - Ultra High Temperature Pasteurization.

UNIT - 3: Major Milk Products

Cream - definition - composition - chemistry of creaming process - gravitational and centrifugal methods of separation of cream - estimation of fat in cream. Butter - definition - composition - theory of churning - desibutter - salted butter estimation of acidity and moisture content in butter. Ghee - major constituents - common adulterants added to ghee and their detection - rancidity - definition - prevention - antioxidants and synergists - natural and synthetic.

UNIT - 4: Special Milk

Standardised milk - definition - merits - reconstituted milk - definition - flow diagram of manufacture - Homogenised milk - flavoured milk - vitaminised milk - toned milk - Incitation milk - Vegetable toned milk - humanized milk - condensed milk - definition, composition and nutritive value.

UNIT - 5: Fermented and other Milk Products

Fermented milk products - fermentation of milk - definition, conditions, cultured milk - definition of culture - example, conditions - cultured cream, butter milk - Bulgaxious milk - acidophilous milk – Yoheer Indigeneous products - khoa and chhena definition - Ice cream - definition - percentage composition - types - ingredients - manufacture of ice - cream

stabilizers - emulsifiers and their role milk powder - definition - need for making milk powder - drying process - types of drying

REFERENCE BOOKS:

1. Robert Jenness and S. Patom, Principles of Dairy Chemistry, S.Wiley, New York, 2005.
2. K. S. Rangappa and K.T. Acharya, Indian Dairy Products, Asia Publishing House New Delhi, 1974.
3. F.P. Wond, Fundamentals of Dairy Chemistry, Springer, Singapore, 2006.
4. K. Bagavathi Sundari, Applied Chemistry, MJP Publishers, first edition, 2006.
5. Sukumar De, Outlines of Dairy Technology, Oxford University Press, New Delhi, 1980.

NON-MAJOR ELECTIVE: FOOD CHEMISTRY

SEMESTER I&II	SUBJECT CODE:	NON-MAJOR ELECTIVE	MARKS 100	CREDITS 2	HOURS 30

Objectives:

To create knowledge on chemistry of various food products, adulteration and toxicology.

UNIT - 1: Food Adulteration

Sources of food, types, advantages and disadvantages. Food adulteration - contamination of Wheat, Rice, Milk, Butter etc. with clay stones, water and toxic chemicals - Common adulterants, Ghee adulterants and their detection. Detection of adulterated foods by simple analytical techniques.

UNIT - 2: Food Poison

Food poisons - natural poisons (alkaloids - nephrotoxin) - pesticides, (DDT, BHC, Malathion) - Chemical poisons - First aid for poison consumed victims.

UNIT - 3: Food Additives

Food additives - artificial sweetners - Saccharin - Cyclomate and Aspartate.Food flavours - esters, aldehydes and heterocyclic compounds. Food colours – Emulsifying agents – preservatives - leavening agents. Baking powder - yeast - taste makers - MSG vinegar.

UNIT - 4: Beverages

Beverages - soft drinks - soda - fruit juices - alcoholic beverages examples. Carbonation - addiction to alcohol – diseases of liver and social problems.

UNIT - 5: Edible Oils

Fats and oils - Sources of oils - production of refined vegetable oils - preservation. Saturated and unsaturated fats - iodine value - role of MUFA and PUFA in preventing heart diseases - determination of iodine value, RM value, saponification values and their significance.

REFERENCEBOOKS:

1. M. Swaminathan, Food Science and Experimental Foods, Ganesh and Company, 1979.
2. Jayashree Ghosh, Fundamental Concepts of Applicated Chemistry, S. Chand & Co. Publishers, second edition, 2006.
3. Thanlamma Jacob, Text Books of Applied Chemistry for Home Science and Allied Sciences, Macmillan, 1979.

NON-MAJOR ELECTIVE: FORENSIC CHEMISTRY

SEMESTER I&II	SUBJECT CODE:	NON-MAJOR ELECTIVE	MARKS 100	CREDITS 2	HOURS 30

Objectives:

To deliver knowledge on chemistry involved in the forensic science.

UNIT - 1: Poisons

Poisons - types and classification - diagnosis of posions in the living and the dead - clinical symptoms - postmortem appearances. Heavy metal contamination (Hg, Pb, Cd) of sea foods - use of neutron activation analysis in detecting arsenic in human hair. Treatment in cases of poisoning - use of antidotes for common poisons.

UNIT - 2: Crime Detection

Accidental explosion during manufacture of matches and fireworks (as in Sivakasi). Human bombs - possible explosives (gelatin sticks and RDX) - metal defector devices and other security measures for VVIP - composition of bullets and detecting powder burns.

UNIT - 3: Forgery and Counterfeiting

Documents - different types of forged signatures - simulated and traced forgeries - inherent signs of forgery methods - writing deliberately modified - uses of ultraviolet rays - comparison of type written letters - checking silver line water mark in currency notes - alloy analysis using AAS to detect counterfeit coins - detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond.

UNIT - 4: Tracks and Traces

Tracks and traces - small tracks and police dogs - foot prints - costing of foot prints - residue prints, walking pattern or tyre marks - miscellaneous traces and tracks - glass fracture - tool marks - paints - fibers - Analysis of biological substances - blood, semen, saliva, urine and hair - Cranial analysis (head and teeth) DNA Finger printing for tissue identification in dismembered bodies - detecting steroid consumption in athletes and race horses.

UNIT - 5: Medical Aspects

Aids - causes and prevention - misuse of scheduled drugs - burns and their treatment by plastic surgery. Metabolite analysis using mass spectrum - Gas chromatography.Arson - natural fires and arson - burning characteristics and chemistry of combustible materials - nature of combustion. Ballistics - classification - internal and terminal ballistics - small arms - laboratory examination of barrel washing and detection of powder residue by chemical tests.

REFERENCEBOOKS:

1. T. H. James, Forensic Sciences, Stanley Thornes Ltd, 1987.
2. Richard Saferstin and Criminalistics - An Introduction to Forensic Science (College Version), Sopfestein, Printice hall, eighth edition, 2003.

NON-MAJOR ELECTIVE: CHEMISTRY IN EVERY DAY LIFE

SEMESTER I&II	SUBJECT CODE:	NON-MAJOR ELECTIVE	MARKS 100	CREDITS 2	HOURS 30

Objectives:

To learn chemistry involved in our day-by-day life.

UNIT –1

General survey of chemicals used in everyday life. Air - components and their importance; photosynthetic reaction, air pollution, green - house effect and the impact on our life style. Water - Sources of water, qualities of potable water, soft and hard water, methods of removal of hardness - water pollution.

UNIT –2

Building materials - cement, ceramics, glass and refractories - definition, composition and application only. Plastics, polythene, PVC, bakelite, polyesters, melamine-formaldehyde resins - preparation and uses only.

UNIT - 3

Food and Nutrition - Carbohydrates, Proteins, Fats - definition and their importance as food constituents - balanced diet - Calorie - minerals and vitamins (sources and their physiological importance). Cosmetics - Tooth pastes, face powder, soaps and detergents, shampoos, nail polish, perfumes - general formulation and preparations - possible hazards of cosmetics use.

UNIT - 4

Chemicals in food production - fertilizers - need, natural sources; urea, NPK fertilizers and super phosphate. Fuel - classification - solid, liquid and gaseous; nuclear fuel - examples and uses.

UNIT - 5

Pharmaceutical drugs - analgesics and antipyretics - paracetamol and aspirin. Colour chemicals - pigments and dyes - examples and applications. Explosives - classification and examples.

REFERENCE BOOKS:

1. Randolph. Norris Shreve, Chemical Process Industries, McGraw-Hill, Texas, fourth edition, 1977.
2. W. A. Poucher, Joseph A. Brink, Jr. Perfumes, Cosmetics and Soaps, Springer, 2000.
3. A. K. De, Environmental Chemistry, New Age International Public Co., 1990.

CORE THEORY – 3: ORGANO-OXYGEN COMPOUNDS

SEMESTER III	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To strengthen the knowledge about oxygen compounds.

UNIT - 1: Alcohols, Ethers, Epoxides and Phenols (10 hrs)

Alcohols: Mono hydric alcohols – nomenclature - preparation, properties - acidity, reactions of alcohols. Dihydric alcohols – nomenclature, preparation, properties, chemical properties and reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4]. Trihydric alcohols – preparation and properties of glycerol.

Ethers and Epoxides (oxiranes): Aliphatic and aromatic ethers – nomenclature – preparation and properties. Preparation and reactions of epoxides.

Phenols: Classification, nomenclature, acidity. Preparation and properties of Phenol, α-Naphthol, β - Naphthol and their electrophilic substitution reactions.

UNIT –2: Aldehydes and Ketones (15 hrs)

Preparation of aldehydes and ketones - acidity of alpha hydrogen - Mechanism of enolization reactions - nucleophilic addition (RMgX, HCN, $NaHSO_3$, NH_3, NH_2OH, $C_6H_5NHNH_2$). Mechanism of reductions with $NaBH_4$, $LiAlH_4$, Wolf-Kishner and MPV reaction, oxidation, haloform reaction and Michael addition. Electrophilic substitution reactions of aromatic aldehydes and ketones.

Mechanism of Norrish Type - I & Type - II, Cannizaro reaction, Aldol condensation, Claisen condensation, Reformatsky reaction, Perkin, Knoevenagel reactions, benzoin condensation and Wittig reaction.

UNIT –3: Carboxylic Acids and its Derivatives (10 hrs)

Carboxylic acid - preparation and properties of mono carboxylic acid - effect of substituent on acidity - hydroxy acids (Lactic, Tartaric and Salicylic acid) – unsaturated acids (Crotanic and Cinnamic acid). Preparation and properties of dicarboxylic acids (upto 6 carbon) and aromatic diacid - Action of heat on hydroxy and dicarboxylicacids - Stereospecific addition of maleic and fumaric acids.

Preparation and reactions of acid chlorides, acid anhydrides and acid amides - Mechanism of Hoffmann reaction and Rosenmund reduction.

UNIT –4: Esters and Active Methylene Compounds (10 hrs)

Prepartion and reaction of ester - Mechanism of Hydrolysis of ester ($B_{Ac}2$, $A_{Ac}2$), Trans - esterification, Clasien ester condensation, fat, wax, soap - Compounds containing active methylene group – keto-enoltautomerism.

Preparation and synthetic applications of malonic ester, acetoaceticesters, cynaoacetic ester, diazo methane and diazoacetic ester.

UNIT –5: Carbohydrates (15 hrs)

Classificationof carbohydrate, Glucose – mutarotation and chemical properties of glucose – structure – conformation & configuration - open chain, furanose and pyranose forms (evidence) – anomer – epimer. Determination of ring size and configuration.

Fructose – properties – furanose and pyranose form - determination of ring size and configuration.

Interconversion of aldose to ketose, ketose to aldose, arabinose to glucose, glucose to arabinose and glucose to mannose.

Starch and cellulose – Structure, properties and uses.

REFERENCE BOOKS:

1. R. T. Morrison, R. N. Boyd, and S. N. Bhattacharjee. Organic Chemistry, Pearson Education, Asia, seventh edition, 2012.
2. T. W. Graham Solomons, Organic Chemistry, John Wiley & Sons, fifth edition, 1992.
3. A. Carey Francis Organic Chemistry, Tata McGraw-Hill Education Pvt., Ltd., New Delhi, seventh edition, 2009.
4. I. L. Finar, Organic Chemistry, Wesley Longman Ltd, England, sixth edition, 1996.
5. J. A. Joule and G. F. Smith. Heterocyclic Chemistry, England, Van Nostrand Reinhold (UK) Co., Ltd., second edition, 1984.
6. P. L. Soni, and H. M.Chawla - Text Book of Organic Chemistry, New Delhi, Sultan Chand & Sons, twenty ninth edition, 2007.

CORE THEORY – 4: CHEMISTRY OF s-BLOCK & p-BLOCK ELEMENTS

SEMESTER IV	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To know the nature of compounds formed by s - and p - block elements; to understand the aspects in gaseous, liquid and solid states; to understand the crystal structures of ionic compounds.

UNIT - 1: Chemistry of s-Block Elements (10 hrs)

Characteristic properties of s-blocks elements, preparation, properties and uses of NaOH, Na_2CO_3, KBr and $KClO_3$. Hydrides – Classification as ionic, molecular and metallic hydrides, Preparation, important properties and uses of $LiAlH_4$ and CaH_2. Comparative study of the element with respect to oxides, hydroxides, halides, carbonates and bicarbonates. Diagonal relationship of Li and Mg. Anomalous behavior of Li and Be. Extraction of beryllium. Chemical properties of metals: reaction with water, air and nitrogen.

UNIT - 2: Boron and Carbon Family (15 hrs)

Extraction of B and Si - Compounds of boron with oxygen - Preparation, properties and uses of boron sesquioxide, borates, borax, sodium peroxoborates. - Compounds of Boron with nitrogen - Preparation, properties and uses of Boron nitride, Borazine. Boron hydrides - Preparation, properties, uses and structure of diborane, reaction with ammonia, hydroboration.

Aluminium - Extraction of Aluminium and its uses, Alloys of Aluminium, amphoteric behavior, aluminates. Comparison of carbon with silicon, Manufacture and uses of CO and CO_2 (includes dry ice); allotropy of carbon and carbides. Preparation, types and industrial applications of carbides, interstitial carbides and covalent carbides.

Silicates - Types of silicates – application of silicates in technology - alkali silicates, ceramics and glass. Preparation, properties and uses of silicones. Tin – Allotropic forms of Tin, alloys of tin, tinning, tin plating. Lead - lead accumulator (discharging and recharging), lead pigments.

UNIT - 3: Nitrogen and Oxygen Group Elements (15 hrs)

Metallic and non metallic character of group 15 elements; hydrides and halides of group-15 elements - hydrazine, hydroxylamine, phosphene; ammonium nitrate, sodium bismuthate - properties and uses. Oxides of group 15 elements: oxides of nitrogen - dinitrogen tetroxide, dinitrogen pentoxide; oxides of phosphorus - oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, oxoacids of phosphorus - orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri- and tetra polyphosphoric acids;

Group-16 (oxygen group): Ozone, oxides - normal oxides, peroxides, suboxides, basic oxides, amphoteric oxides, acidic oxides, neutral oxides. Oxides of sulphur - SO_2, SO_3; oxoacids of sulphur - thionic acid series, peroxoacid series, oxohalides - thionyl compounds, sulfuryl compounds (methods of preparation and properties).

UNIT - 4: Halogens **(10 hrs)**

Ionic – covalent - bridging halides, reactivity of halogens, reduction of halogens by thiosulfate. Halogen oxides: oxygen difluoride, dioxygen difluoride, dichlorine monoxide, chlorine dioxide, dichlorine hexoxide, dichlorine heptoxide; bleaching powder - estimation of available chlorine; bromine dioxide, iodine pentoxide. Oxoacids of halogens: hypohalous acid (HOX), halous acid (HXO_2), halic oxide (HXO_3), perhalic acid (HXO_4), strength of oxoacids. Inter-halogen compounds: ClF, ICl, ClF_3, BrF_3, IF_3, ClF_5, BrF_5, IF_5; poly halides.

UNIT - 5: Noble Gases **(10 hrs)**

Noble gases: Position in the periodic table – general characteristics – structure and shape of Xenon compounds – XeF_2, XeF_4, XeF_6, $XeOF_4$ – uses of Noble gases. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds. Chemistry of xenon: structure and bonding of xenon fluorides, - oxides and oxyfluorides of xenon.

TEXT BOOKS:

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, New Delhi, Milestone publishers and distributors, thirteenth edition,2009.
2. P. L. Soni and Mohan katyal, Textbook of Inorganic Chemistry, Sultan Chand & Sons, twentieth edition,2006.
3. J. D. Lee Concise Inorganic Chemistry, Blackwell science, fifth edition, 2005.

REFERENCE BOOKS:

1. A. K. De, Text book of Inorganic Chemistry, Wiley East Ltd, seventh edition, 1992.
2. W.U. Malik, G.D. Tuli and R.D. Madan, Selected Topics in Inorganic Chemistry; S. Chand and Co, 2014.
3. R. C. Agrawal, Modern Inorganic Chemistry, Kitab Mahal, first edition, 1987.
4. K. N. Upadhayaya, Text book of Inorganic Chemistry, Vikas Publishing House, New Delhi, 1990.
5. Peter Atkins, Tina Overton, Jonathan Rourke and Mark Weller, Inorganic Chemistry, Oxford University Press, sixth edition, 2014.

CORE PRACTICAL – 2: INORGANIC QUALITATIVE ANALYSIS

SEMESTER III&IV	SUBJECT CODE:	PRACTICAL	MARKS 100	CREDITS 3	HOURS 45

Objectives:

To develop the skill on systematic analysis of inorganic salts.

Semi - Micro Qualitative Analysis

1. Analysis of simple acid radicals:
   Carbonate, sulfide, sulfate, thiosulfite, chloride, bromide, iodide, nitrate
2. Analysis of interfering acid radicals:
   Fluoride, oxalate, borate, phosphate, arsenate, arsenite.
3. Elimination of interfering acid radicals and Identifying the group of basic radicals
4. Analysis of basic radicals (group wise):
   Lead, copper, bismuth, cadmium, tin, antimony, iron, aluminium, arsenic, zinc, manganese, nickel, cobalt, calcium, strontium, barium, magnesium, ammonium
5. Analysis of a mixture - I to VIII containing two cations and two anions (of which one is interfering type)

REFERENCE BOOK:

1. V. Venkateswaran, R. Veeraswamy and A. R. Kulandivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, New Delhi, second edition, 1997.

CORE THEORY – 5: ORGANO NITROGEN COMPOUNDS AND NATURAL PRODUCTS

SEMESTER IV	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To introduce chemistry of nitrogen compounds and natural products namely amino acids, proteins and alkaloids.

UNIT – 1: Amines, Diazonium Compounds and Nitro Compounds (15 hrs)

Aliphatic and aromatic amines: Preparation of primary, secondary and tertiary amines. Reactions: basicity of amines, effect of substituent on basicity of aromatic amines. Some sulpha drugs, Diazonium salts: Preparation, diazotization reactions, replacement reactions (Sandmeyer, Gatterman and Gomberg reactions), coupling reactions.

Nitro compounds: Nomenclature and classification, aliphatic and aromatic nitro compounds, general properties, preparation by nitration. Reactions: reduction by chemical and electrolytic methods. Di- and tri- substitution of aromatic nitro compounds: synthesis of o- , m- , p- dinitrobenzenes and trinitrobenzene.

UNIT –2: Amino acids and Proteins (15 hrs)

Classification, structure and stereochemistry of amino acids, Acid - base behavior isoelectric point and electrophoresis, preparation and reactions of α - amino acids, Structure and nomenclature of peptides and proteins, Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides, classical peptide synthesis, solid - phase peptide synthesis, Structure of peptides and proteins, Levels of protein structure, Protein denaturation / renaturation.

UNIT –3: Nucleic acids and Heterocyclic Compounds (10 hrs)

Introduction, constituents of nucleic acids, ribonucleosides and ribonucleotides. The double helical structure of DNA. Molecular orbital picture and aromatic characterisatics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, mechanism of nucleophilic substitution reaction in pyridine derivatives, comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five and six membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis, Bischler-Napieralski synthesis. Electrophilic substitution reactions mechanism of indole, quinolone and isoquinoline.

UNIT –4: Alkaloids **(10 hrs)**

Alkaloids: Definition, Occurrence, extraction of alkaloids from plants, general properties, determination of the chemical constitution of the alkaloids, functional group analysis, estimation of groups, degradation and synthesis. Structures of Coniine, Piperine and Nicotine.

UNIT –5: Terpenoids **(10 hrs)**

Terpenoids: Classification, isoprene rule, isolation and general properties, occurrence, general structure and physical properties of geraniol, citral, menthol, α - pinene and camphor.

REFERENCE BOOKS:

1. R. T. Morrison, and R. N. Boyd, Organic Chemistry, Pearson Education, Asia, sixthedition, 2002.
2. T.W. Graham Solomons, Organic Chemistry, John Wiley & Sons, eleventh edition, 2012.
3. A. Carey Francis, Organic Chemistry, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, seventh edition, 2009.
4. I. L. Finar, Organic Chemistry, Vol. (1& 2), England, Wesley Longman Ltd, sixth edition, 1996.
5. J. A. Joule, and G. F. Smith. Heterocyclic Chemistry, VanNostrand Reinhold (UK) Co. Ltd., England, second edition, 1984.
6. P. L.Soni, and H. M. Chawla, Text Book of Organic Chemistry, Sultan Chand & Sons, New Delhi, twenty ninth edition, 2007.

CORE THEORY – 6: CHEMICAL KINETICS AND ELECTROCHEMISTRY

SEMESTER V	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To understand the concepts of kinetics of chemical reaction and electrochemistry.

UNIT –1: Chemical Kinetics - I **(10 hrs)**

Rate of reaction - average and instantaneous rate - rate equation – order and molecularity - rate laws - rate constants - derivation of rate constants and characteristics for first, second, third and zero order reactions - derivation of time for half change with examples - methods for determination of order of reaction – experimental methods of determination of rate constant of reactions – volumetry, manometry and polarimetry.

UNIT –2: Chemical Kinetics - II **(15 hrs)**

Effect of temperature on reaction rates - concept of activation energy - Arrhenius equation - Collision Theory - derivation of rate constant for bimolecular reactions - failure of collision theory - Lindemann's Theory of unimolecular reactions – theory of absolute reaction rates - derivation of rate for bimolecular reaction - significance of entropy and free energy of activation - comparison of collision theory and ARRT - consecutive, parallel and reversible reactions (no derivation, only examples)

Catalysis: Definition - characteristics of a catalyst - homogeneous and heterogeneous catalysis - function of a catalyst in terms of Gibb's free energy of activation - kinetics of acid-base and enzyme catalysis - heterogeneous catalysis - kinetics of unimolecular surface reactions.

Adsorption: Physisorption and chemisorptions - Freundlich adsorption isotherm - Langmuir adsorption isotherm – applications of adsorption

UNIT - 3: Electrical Conductance **(15 hrs)**

Electrical transport and conductance in metal and in electrolytic solution. Specific conductance and equivalent conductance. Measurement of equivalent conductance using Kohlraush's bridge - Arrhenius theory of electrolytic dissociation and its limitation - Weak and strong electrolyte according to Arrhenius theory, Ostwald's dilution laws - applications and limitation - Variation of equivalent conductance with concentration.

Migration of ion - ionic mobility. Kohlraush's law and its applications. The elementary treatment of the Debye-Huckel Onsager equation for strong electrolytes, evidence for ionic atmosphere, the conductance at high fields (Wein effect) and high frequencies (Debye - Falkenhagen effect), Transport number & Hittorf's rule. Determination by Hittorf's method and moving boundary method. Application of conductance measurements - Determination of λ_o of strong electrolytes. Determination of K_a of weak acids. Determination

of solubility product of a sparingly soluble salt, common ion effect and conductometric titrations.

UNIT - 4: Electrochemical Cells - I (10 hrs)

Electrolytic and Galvanic cells – Reversible and irreversible cells. Conventional representation of electrochemical cells. Electromotive force of a cell and its measurement - calculation of thermodynamic quantities of cell reactions (ΔG, ΔH, ΔS and K) - application of Gibbs Helmholtz equation and Nernst equation.

Types of reversible electrodes – Gas/metal - metal ion/ metal - insoluble salt and redox electrodes. Electrode reactions – Nernst equation – Derivation of cell E. M. F and single electrode potential, standard hydrogen electrode – reference electrodes – standard electrode potentials – sign convention – Electrochemical series and its significance.

UNIT - 5: Electrochemical Cells - II (10 hrs)

Concentration cell with and without transport - Liquid junction potential - Application of EMF concentration cells. Valence of ion, solubility product and activity co-efficient. Potentiometric titrations. Determination of pH using Hydrogen, quinhydrone and glass electrodes - Corrosion – general and electrochemical theory – passivity – prevention of corrosion.

TEXT BOOKS:

1. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Shobanlal Nagin Chand and Co. Jalendhar, forty first, edition, 2001
2. S. H. Maron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan limited, New York, 1992.
3. S. K. Dogra and S. Dogra, Physical Chemistry through Problems: New Age International, fourth edition, 1996.

REFERENCE BOOKS:

1. Gilbert. W. Castellen, Physical Chemistry, Narosa Publishing House, third edition, 1985.
2. P. W. Atkins, and Julio de Paula, Physical Chemistry, Oxford University press, seventh edition, 2002.
3. K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India Ltd, third edition, 2009.

CORE THEORY – 7: SPECIAL TOPICS IN CHEMISTRY

SEMESTER V	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To emphasize the fundamentals of stereochemistry, group theory and photochemistry, molecular rearrangement and their applications.

UNIT - 1: Stereochemistry - I (10 hrs)

Stereoisomerism – classification; Optical isomerism – optical activity, specific rotation (calculation) – asymmetric center – chirality – achiral molecules. Elements of symmetry. Optical activity of biphenyls, allenes and spiranes. Racemisation and methods; resolution and methods.

Asymmetric synthesis: Partial and absolute – Cram's rule (Elementary approach only) - Walden inversion.

UNIT –4: Stereochemistry - II (15 hrs)

Projection formula – flying wedge, Fischer, Sawhorse and Newmann – interconversion - d, l and D, L notations of optical isomers – CIP rules – R and S nomenclature - optical isomers up to three chiral carbon atoms. Meso, dl, erythro and threo representations.

Geometrical isomerism – cis and trans, syn-anti and E-Z nomenclature. Geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes. Methods of distinguishing geometrical isomers. Geometrical isomerism of disubstituted cyclohexanones.

Conformational analysis - conformers, configuration, dihedral angle and torsional strains. Conformational analysis of ethane and disubstituted ethane derivatives, conformers of cyclohexane, bonds - ring flipping, mono and disubstituted cyclohexanes.

UNIT –3: Group Theory (15 hrs)

Symmetry elements and symmetry operations - symmetry operation of water molecule, illustration of mathematical rules for the group using symmetry operations of water molecule. Construction of group multiplication table for water molecule. Point groups - definition. Symmetry elements and symmetry operations of the following groups – C_2, C_3, C_{2v}, C_{3v}, C_{2h}.

UNIT –4: Photochemistry (10 hrs)

Laws of photochemistry – Lambert - Beer's law – Grothus – Draper law and Stark Einstein law–Quantum efficiency –reasons for high and low quantum yield - comparison between thermal and photochemical reactions – rate law – kinetics of H_2 , Cl_2, H_2 and Br_2 reactions.

UNIT –5: Molecular Rearrangements (10 hrs)

Types of rearrangements - mechanism of pinacol-pinacolone, benzyl-benzilic acid, bezindine, Favorski, dienone- phenol, Claisen, Fries, Hoffmann, Curtius, Schmidt and Beckmann rearrangements.

TEXT BOOKS:

1. B. R. Puri, Sharma. L. R and Kalia, K. C,Principles of Inorganic Chemistry, S. Chand Publications, New Delhi, twenty third edition, 1993.
2. J. D. Lee, Concise Inorganic Chemistry, UK Blackwell Science, (Oxford), fifth edition, 1996.
3. P.L. Soni, Mohankatyal, Text Book of Inorganic Chemistry, Sultan Chand & sons, New Delhi, twentieth edition, 2006.
4. S. Swarnalakshmi, T. Saroja, R. M. Ezhilarasi; A Simple Approach to Group Theory in Chemistry Universities Press (India) Pvt. Ltd., first edition, 2008.
5. M. K. Jain, S. C. Sharma Modern Organic Chemistry, Vishal Publishers, fourth edition, 2009.
6. B.R. Puri Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., fourty second, edition, 2008.
7. P. S. Kalsi, Stereochemistry - Conformation & Mechanism, New Age International limited, sixth edition, 2006.
8. P. S. Kalsi, Stereochemistry and Mechanisms through Solved Problems, New Age International limited, third edition, 2001.

REFERENCE BOOKS:

1. S.H. Maron and C.F. Prutton, Physical Chemistry, McMillan, London fourth edition, 1965.
2. P. W. Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, seventh edition, 2002.
3. G. W. Castellan, Physical Chemistry, Narosa Publishers, fourth edition, 2004.
4. H. J. Arnikar, Essentials of Nuclear Chemistry, New Age International Publishers, fourth edition, 1995.

CORE THEORY - 8: ANALYTICAL CHEMISTRY-I

SEMESTER V	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

- *To build a basic knowledge on generation of analytical data in an appropriate manner; to provide thorough knowledge on gravimetry.*
- *To expertise the instrumental methods of chemical analysis for microgram level; to cultivate the analytical skill in the structural identification of chemical compounds.*

UNIT –1: Data Analysis and Sampling (15 hrs)

Precision, accuracy, theory of errors, idea of significant figures and its importance with examples, methods of expressing accuracy, error analysis, minimizing errors, methods of expressing precision, average, deviation, standard deviation and confidence limit; analytical balance; elementary aspect of calibration, calibration of glassware and other equipments for quantitative chemical analysis.

Sampling – Significance of sampling, types of sample, sampling methods for solids, liquid and gases.

UNIT –2: Gravimetry (10 hrs)

Gravimetric analysis – principle, precipitating agent, condition of precipitation; selective and specific precipitants–DMG, cupferron, salicylaldehyde, ethylenediamine; use of sequestering agent, coprecipitation and post precipitation, peptisation, calculations in gravimetric method and gravimetric factor.

UNIT –3: Separation Techniques (15 hrs)

Separation by precipitation; solvent extraction–types and applications; Chromatographic techniques – types, principle, theory and applications of column and ion–exchange chromatography; thin layer and paper chromatography; gas liquid chromatography and high performance liquid chromatography.

UNIT –4: Purification Techniques (10 hrs)

Drying of solid, distillation–principle, types, and experiments of simple distillation, fractional, steam, azeotrope and vacuum distillation; Soxhlet extraction, recrystallization, fractional crystallization, sublimation.Testing of purity – determination of melting point, boiling point, refractive index and density.

UNIT –5: Polarimetry and Thermal analysis (10 hrs)

Polarimetry – principle, instrumentation and applications; estimation of glucose. Thermo–analytical methods: Principle involved in thermogravimetric analysis and differential thermal analysis, discussion of various components with block diagram, characteristics of TGA and DTA – factors affecting TGA and DTA curves.

TEXT BOOKS:

1. R. Gopalan, K. Rengarajan, P. S. Subramanian, Elements of Analytical Chemistry, Sultan Chand & Sons, third edition, 2003.
2. David Harvey, Modern Analytical Chemistry, Tata McGraw-Hill, first edition, 2000.
3. J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, Vogel's Text book of Quantitative Chemical Analysis, Pearson Education Pvt. Ltd, sixth edition,2004.

REFERENCE BOOKS:

1. Douglas A. Skoog, Donald M. West and F. James Holler, Fundamentals of Analytical Chemistry Harcourt Asia Pvt. Ltd., ninth edition, 2001.
2. Douglas A. Skoog, Donald M. West and F. James Holler, Analytical Chemistry, An Introduction; Saunders College Publishers, seventh edition, 2000.
3. Dean, John A. Merritt, Lynne L., Jr. Settle, Frank A., Jr. Willard, Hobart H, Instrumental Methods of Analysis, Wadsworth Publishing Co Inc., seventh edition, 1988.
4. Skoog D. A., Principles of Instrumental Analysis, Saunders College Publishing, fifth edition, 1998.

CORE THEORY–9: THERMODYNAMICS AND SOLUTIONS

SEMESTER VI	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To strengthen the knowledge on Thermodynamics and Solutions.

UNIT – 1: Thermodynamics I (15 hrs)

Definition and explanation of terms - System –surrounding - open, closed and isolated systems - state of system - intensive and extensive properties - Thermodynamic equilibrium - Thermodynamic processes - isothermal, adiabatic, reversible, irreversible and cyclic processes - state and path functions - exact and inexact differentials - concept of heat and work - work of expansion at constant pressure and free expansion.

First law of Thermodynamics - statement and equation - definition of internal energy(U), Enthalpy(H) and heat capacity - relation between C_p and C_v - Calculation of W, q, ΔU andΔH for expansion of ideal gases under reversible isothermal and adiabatic conditions – Joule - Thomson effect - Calculation of μ_{JT} for ideal and real gases - inversion temperature and its significance. Thermo chemistry - Relation between enthalpy of reaction at constant volume (q_v) and at constant pressure(q_p), variation of enthalpy of reaction with temperature - Kirchhoff's equation - enthalpy of Combustion - Flame and explosion temperature - heat of neutralization - heat of formation - integral heat of solution and dilution - Bond energy and its calculation from thermo chemical data - Hess's law and its applications.

UNIT –2: Thermodynamics II (10 hrs)

Second Law of Thermodynamics - Need for second law - different statements of second law - spontaneous process - concept of entropy – definition - entropy of an ideal gas - entropy changes in reversible, cyclic and physical transformations - physical significance of entropy - calculation of entropy changes with changes in P, V, T and entropy of mixing - Entropy criterion for spontaneous and equilibrium processes - Gibb's free energy(G) and Helmholtz free energy(A) – variation of G and A with P, V and T - Criteria for Spontaneity - Gibb's - Helmholtz equation and its applications.

UNIT –3: Thermodynamics III (10 hrs)

Third Law of Thermodynamics - Nernst heat theorem - statement of Third Law of Thermodynamics - Determination of absolute entropy from heat capacity measurements - exceptions to third law.

Thermodynamic treatment of law of mass action – van't Hoff reaction isotherm - Standard free energy change with equilibrium constant - Variation of equilibrium constant with temperature change - van't Hoff isotherm. Partial molar properties - Chemical potential - Gibb's Duhem equation - effect of pressure and temperature on chemical potential –Duhem

Margulus equation - concept of fugacity and activity - determination of fugacity of gas - activity and activity coefficient – Clapeyron-Clausius equation - derivation and its uses.

UNIT –4: Solutions and Colloids (15 hrs)

Ideal and non - ideal solutions - solutions of liquids in liquids - Raoult's law - binary liquid mixtures - deviations from ideal behavior - vopour pressure – composition and vapour pressure - temperature curves - azeotropic distillation – Ethanol-water system and HCl-Water system - partially miscible liquid systems - phenol - water system, triethylamine - water, Nicotine - water system - effect of impurities on CST - completely immiscible liquids - steam distillation - solutions of gases in liquids - Henry's law.

Dilute solutions: Colligative properties - relative lowering of vapour pressure - thermodynamic derivation of elevation of boiling point - depression of freezing point - calculation of molecular weight - osmosis - laws of osmotic pressure, distribution law - thermodynamic derivation and application.

Colloids: Definition - types - preparation and purification of colloids - properties - kinetic, optical and electrical stability of colloids - gold number. Emulsions: types, preparation, properties and applications.

Gels: types, preparation, properties and applications.

UNIT –5: Phase Equilibria (10 hrs)

Definition of terms in phase rule – derivation and application to one component system - water and sulphur – super cooling, sublimation. Two component systems – Solid liquid equilibria, simple eutectic lead – silver (desilverisation of lead), Bi-Cd; compound formation with congruent melting point (Mg - Zn, $FeCl_3$ – H_2O) and incongruent melting point (Na - K, Na_2SO_4 - H_2O).

REFERENCE BOOKS:

1. B.R. Puri and L.R. Sharma, Principles of Physical Chemistry, ShobanLalNagin Chand and Co., thirty three edition, 1992.
2. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan limited, NewYork, 1966.
3. S.K. Dogra and S. Dogra, Physical Chemistry Through Problems, New age international, fourth edition, 1996.
4. Gilbert. W. Castellan, Physical Chemistry, Narosa publishing house, third edition, 1985.
5. P. W. Atkins, and Julio de Paula, Physical Chemistry, Oxford University press, seventh edition, 2002.
6. J. Rajaram and J.C. Kuriacose, Thermodynamics, ShobanLalNagin Chand and CO., 1986.
7. K. L. Kapoor, A Textbook of Physical chemistry, (volume-2 and 3), Macmillan, India Ltd, third edition, 2009.

CORE THEORY–10: CHEMISTRY OF d-BLOCK & f-BLOCK ELEMENTS AND COORDINATION CHEMISTRY

SEMESTER VI	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To learn the chemistry of elements present in the d- and f-blocks of periodic table.

UNIT - 1: Transition Elements (15 hrs)

Characteristic properties of d-block elements: magnetic property, reactivity, variable oxidation states, lower oxidation states and stabilization, catalytic properties, comparative study of the elements of the first transition series with reference to size, ionization potentials, redox potentials, magnetic behaviour, oxidation states and ability to form complex compounds, trends in chemical and physical properties in passing from first to second and third series; important uses of transition metals and their alloys.

Metallurgy of Ti, V, W, Cr. M-M bonding and cluster compounds; oxides, mixed oxides, halides, and oxohalides of transition metals; synthesis and reactivity of vanadates, chromates, dichromate, molybdates, tungstates, tungsten bronzes, manganite and permanganate; polycations.

UNIT - 2: Chemistry of f-Block Elements (10 hrs)

General characteristics of f-block elements - comparative account of lanthanides and actinides.

Lanthanides: lanthanide contraction, similarity in properties, occurrence, oxidation states, chemical properties of Ln(III) cations, magnetic properties. Color and electronic spectra of lanthanide compounds.Separation of lanthanides: solvent extraction, ion exchange, chemical properties of Ln (III) metal ions.

Actinides: occurrence, preparation of actinides, oxidation states, general properties, the later actinide elements. Uranium - occurrence, metallurgy; chemical properties of hydrides, oxides, and halides. Preparation, properties and uses of ceric ammonium sulphate, thorium dioxide, thorium nitrate, uranium hexafluoride, uranyl acetate.

UNIT - 3: Coordination Chemistry (15 hrs)

Review of the fundamentals of coordination chemistry: Distinction between double salts and coordination compounds - Terminology, types of ligands - monodentate, bidentate, polydentate and ambidendate ligands, IUPAC rules of nomenclature of coordination ligands, mononuclear and dinuclear complexes; chelate effect. Stable, unstable, inert and labile complexes - methods of preparation of complexes - detection of complex formation - applications of complexes in analysis and metallurgy. Factors affecting the stability of complexes.

Isomerism: linkage, ionization, hydrate, coordination, coordination position isomerism, geometrical (cis and trans and facial and merdional), optical isomerism in 4 - coordinated and 6-coordinated complexes, trans effect, stability of coordination compounds – overall and step wise stability constants.

UNIT - 4: Theories of Coordination Complexes (10 hrs)

Werner's coordination theory, Sidgwick's theory - EAN rule and stability, valence bond theory, 4-coordinate complexes, 6-coordinate complexes - Inner and outer orbital complexes, hybridization, geometry, magnetism, limitations of VBT. Crystal field theory: crystal field effects, crystal field splitting in octahedral, tetragonally distorted octahedral geometry, tetrahedral geometries and square planar complexes - high - spin and low - spin complexes; CFSE and factors affecting it; computation of CFSE; evidences of crystal field splitting; spectrochemical series.

UNIT - 5: Reaction Mechanisms in Coordination Compounds and Synthesis of Coordination Compounds (10 hrs)

Substitution reactions in octahedral complexes: dissociative and associative and interchange mechanisms. Electron transfer reactions: inner - sphere and outer - sphere mechanisms, non - complementary electron transfer reactions. Inorganic photochemistry: principles, photosubstitution, photoisomerization, and photo redox reactions. Substitution reactions in square planar complexes: dissociative and associative mechanisms. Cis- and trans-effects in synthesis of square planar and octahedral complexes. Metal template synthesis - metal phthalocyanins and Schiff bases. Biological importance of transition metals: biological roles of Cr, Mo, Mn, Fe, Co, Cu, Zn.

TEXTBOOKS:

1. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi, thirtieth edition, 2009.
2. P.L. Soni and Mohan katyal, Textbook of Inorganic Chemistry, Sultan Chand & Sons, twentieth edition, 2006.
3. J.D. Lee, Concise Inorganic Chemistry, Blackwell science, fifth edition, 2005.

REFERENCE BOOKS:

1. A. K. De, Text book of Inorganic Chemistry, Wiley East, seventh edition, 1992.
2. Wahid U Malik, G. D.Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry S. Chand and Co, nineteenth edition, 2014.
3. R. C. Agrawal, Modern Inorganic Chemistry, Kitab Mahal, first edition, 1987.
4. K. N. Upadhayaya, Text book of Inorganic Chemistry, Vikas Publishing House, New Delhi,1990.

CORE THEORY – 11: ANALYTICAL CHEMISTRY–II

SEMESTER VI	SUBJECT CODE:	THEORY	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To provide a knowledge on instrumental methods of analytical techniques and spectroscopy.

UNIT –1: Polarography and Diffraction Methods (15 hrs)

Polarography - principle, concentration polarization, dropping mercury electrode, advantages and disadvantages, migration and diffusion currents. Ilkovic equation and significance. Instrumentation - experimental assembly and electrodes. Current voltage curve - oxygen wave - influence of temperature and agitation on diffusion layer. Applications - qualitative and quantitative applications for inorganic systems.

Theory, instrumentation and applications of X - ray, electron and neutron diffraction analyses.

UNIT –2: Atomic and Molecular Spectroscopy (15 hrs)

Principle, instrumentation and applications of Atomic Absorption Spectroscopy and Flame Photometry.

Ultraviolet and Visible spectroscopy: theory, instrumentation and application (qualitative and quantitative) – photometric titrations. Infrared Spectroscopy: Theory, instrumentation and applications. Raman Spectroscopy: Theory, instrumentation and application.

UNIT –3: NMR Spectroscopy (10 hrs)

Nuclear Magnetic Resonance Spectroscopy: Theory, instrumentation and application to the structural determination of organic compounds (simple organic molecule).

UNIT –4: Mass Spectrometry (10 hrs)

Mass Spectrometry: Principle, details of components of mass spectrometer, various analyzers, principles of fragmentation and applications to the organic molecules for structure identification.

UNIT –5: Radio - Analytical Techniques and Computers in Chemistry (10 hrs)

Radio-Analytical technique: Tracer technique, radiocarbon dating, activation analysis, radiometric analysis and titrations and isotopic dilution analysis.

Essentials of computers in chemistry, Fundamentals and applications in chemistry (Data interpretation – softwares for basic chemical calculations and chemical structures).

TEXT BOOKS:

1. R Gopalan, K. Rengarajan, P.S. Subramanian, Elements of Analytical Chemistry, Sultan Chand & Sons, third edition , 2003.
2. David Harvey, Modern Analytical Chemistry, McGraw-Hill, first edition, 2000.
3. R. C. Mendham, J. D. Denney, and Barnes M. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, Pearson Education Pvt. Ltd., sixth edition, 2004.
4. K. V. Raman, Computers in Chemistry, Tata McGraw-Hill Education, first edition,1993.

REFERENCE BOOKS:

1. Douglas A. Skoog, Donald M. West and F. James Holler, Fundamentals of Analytical Chemistry, Harcourt Asia Pvt. Ltd., ninth edition, 2001.
2. Douglas A. Skoog, Donald M. West and F. James Holler, Analytical Chemistry- An Introduction, Saunders College Publishers, seventh edition, 2000.
3. Dean, John A., Merritt, Lynne L., Settle, Frank A., Willard, Hobart H; Instrumental Methods of Analysis, Wadsworth Publishing Co Inc., seventh edition, 1988.
4. D. A. Skoog, Principles of Instrumental Analysis, Saunders College Publishing, Philadelphia, London, fifth edition, 1998.

CORE PRACTICAL – 3: GRAVIMETRIC ANALYSIS

SEMESTER V&VI	SUBJECT CODE:	PRACTICAL	MARKS 100	CREDITS 4	HOURS 60

Objectives:

To develop experimental skill in the gravimetric analysis of inorganic elements.

Gravimetric Estimation:

1. Estimation of Lead as Lead chromate
2. Estimation of Barium as Barium chromate
3. Estimation of Nickel as Nickel-DMG complex
4. Estimation of Calcium as Calcium oxalate
5. Estimation of Barium as Barium sulfate
6. Estimation of sulfate as Barium sulfate
7. Estimation of lead in solder by gravimetry*
8. Estimation of Nickel from stainless steel*

(* For Internal assessment only)

REFERENCE BOOKS:

1. V.Venkateswaran, R.Veeraswamy and A.R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, New Delhi, second edition, 1997.
2. B. S. Furniss, Vogel's Textbook of Practical Organic Chemistry, ELBS - Longman, London, seventh edition, 1984.

CORE PRACTICAL – 4: ANALYSIS AND PREPARATION OF ORGANIC COMPOUNDS

SEMESTER V&VI	SUBJECT CODE:	PRACTICAL	MARKS 100	CREDITS 3	HOURS 45

Objectives:

To exercise the laboratory skill on analysis of organic compounds and preparation of organic compounds.

A. Organic Analysis

a) Qualitative analysis of simple organic compounds:

b) Confirmation by preparation of solids derivatives / characteristics colour reaction.

Note :1. Mono - functional compounds are given for analysis. In the case of bi- functional compounds, students are required to report any one of the functional groups.

2. Each student is expected to do the analysis of at least 15 different organic substances.

B. Organic Preparations and Chromatography Techniques

1. Preparation of Organic compounds involving the following chemical conversions:

i.Oxidation ii.Reduction iii.Esterification iv.Acetylation v.Hydrolysis vi.Nitration vii.Bromination viii.Diazotization ix.Osazone formation.

2. Separation of chlorophyll from the plant extract by column chromatography*.

3. Identification of food colorants by TLC*.

(* For Internal assessment only)

REFERENCE BOOKS:

1. V.Venkateswaran, R.Veeraswamy and A.R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons,New Delhi, second edition, 1997.
2. B. S. Furniss, Vogel's Textbook of Practical Organic Chemistry, ELBS - Longman, London, seventh edition, 1984.

CORE PRACTICAL – 5: PHYSICAL CHEMISTRY PRACTICAL

SEMESTER V&VI	SUBJECT CODE:	PRACTICAL	MARKS 100	CREDITS 3	HOURS 45

Objectives:

To perform the laboratory experiments in order to understand the concepts of physical changes in chemistry.

List of Experiments

1. Critical Solution Temperature
2. Effect of Electrolyte on Critical Solution Temperature
3. Transition Temperature
4. Kinetics of Ester Hydrolysis
5. Kinetics of Persulphate - Iodide Reaction.
6. Rast Method
7. Phase Diagram (Simple eutectic System)
8. Conductometric : Acid - Base Titration
9. Potentiometric: Acid - Base Titration

REFERENCE BOOKS

1. V.Venkateswaran, R.Veeraswamy and A.R.Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, New Delhi, second edition, 1997.
2. Daniel, Experimental Physical Chemistry, McGraw-Hill, New York, seventh edition, 1970.
3. A. Findlay, Practical Physical Chemistry, Logman, London, seventh edition, 1959.
4. V. K. Ahluwalia, Sunith Dhingra, and Adarsh. Gulati, College Practical Chemistry, Orient Longman Pvt. Ltd., 2008.
5. K. K. Sharma and D. S. Sharma, Introduction to Practical Chemistry, Vikas Publishing House, New Delhi, 1982.

ELECTIVE-1: NANOCHEMISTRY AND TECHNOLOGY

SEMESTER V&VI	SUBJECT CODE:	ELECTIVE	MARKS 100	CREDITS 5	HOURS 75

Objectives:

To create general awareness on nanomaterials and applications.

UNIT - 1: Background to Nanotechnology (10 hrs)

Origin of nanotechnology - scientific revolution - atomic structures - molecular and atomic size - Bohr radius - Heisenberg's principle. Definitions - Nano, nanoscience, and nano technology, nanograins, nanoclusters, nanoinclusions (Lycurgus cup etc). Nano in nature - difference between bulk and nanomaterials - challenges in nanotechnology - carbon age - new form of carbon (from Graphene sheet to CNT).

UNIT - 2: Preparation and Properties of Nanomaterials – I (15 hrs)

Influence of nucleation rate on the size of the crystals - macroscopic to microscopic crystals and nanocrystals - large surface to volume ratio, top-down and bottom-up approaches - self-assembly process - grain boundary volume in nanocrystals - defects in nanocrystals - surface effects on the properties. Size dependent properties - magnetic, electronic, transport and optical.

UNIT - 3: Preparation and Properties of Nanomaterials – II (20 hrs)

Synthesis of bulk nanostructured materials - Sol gel processing - mechanical alloying and milling - inert gas condensation technique - bulk and nano composite materials - grinding – high energy ball milling - types of balls - WC and ZrO_2- materials – ball ratio – limitations - melt quenching and annealing. Preparation and properties of Carbon Nanotubes (CNT) - Metals (Au, Ag) - Metal oxides (TiO_2, ZnO) - Semiconductors (Si, CdS) - nanocomposites - Dilute magnetic semiconductor. Organic nanomaterials – dendrimers, etc.

UNIT - 4: Applications of Nanotechnology (20 hrs)

Applications - electronics, sensors, catalysis, Nanocomposites (NCMs) and environmental. Current medical practice - treatment methodology - principles of nanomedicine – nanomedical perspective and the medical applications – Nanomedicine: diagnosis, nanopharmaceuticals, biocompatible nanomedical materials. Industrial applications of nanomaterials: nanocoatings and nanotextilesas antibacterial and anti - odour agents in deodorant/antiperspirant, shaving/depilatory products, foot powder, oral care.

UNIT –5: Nanotoxicity **(10 hrs)**

Ethical, safety and regulatory issues of nanomedicine. Nano toxicology: toxicity of carbon nanomaterials, handling of nanomaterials, health implication of nanomaterials, environmental toxicity. Green Nanochemistry.

REFERENCE BOOKS:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic Science and Emerging Technologies, Overseas Press India Pvt. Ltd., New Delhi, first edition, 2005.
2. C. N. R. Rao, A. Muller, A. K. Cheetham , The Chemistry of Nanomaterials Synthesis, Properties and Applications, Wiley VCH Verlag Gmbh &Co., Weinheim, 2004.
3. Kenneth J. Klabunde , Nanoscale Materials Science, John Wiley & Sons, Inc., 2001.
4. C. S. S. R. Kumar, J. Hormes, C. Leuschner, Nanofabrication Towards Biomedical Applications, Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.
5. W. Rainer, Nano Electronics and information Technology, Wiley, 2003.
6. K. E. Drexler, Nano systems, Wiley, 1992.
7. G. Cao, Naostructures and Nanomaterials: Synthesis, Properties and Applications, Imperical College Press, 2004.
8. M. Madou, Fundamentals of Micro-fabrication, CRC press, 1997.
9. G. Timp, Nanotechnology, AIP press, Springer Verlag, New York, 1999.
10. M. J. Jackson, Micro fabrication and Nanomanufacturing, CRC press. 2005.
11. G. Cao, Naostructures and Nanomaterials: Synthesis, Properties and Applications, Imperical College Press, 2004
12. W. T. S Huck, Nanoscale assembly: Chemical Techniques (Nanostructure Science and Technology, Springer, 2005.
13. Robert A. Freitas Jr., Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience, Georgetown, TX, 1999.
14. Robert A. Freitas Jr., Nanomedicine, Volume IIA: Biocompatibility, Landes Bioscience, Georgetown, TX, 2003.
15. Kewal K. Jain, The Hand Book of Nanomedicine, Humana Press, Springer 2008.
16. Challa S. S. R. Kumar, Nanomaterials for Medical Diagnosis and Therapy, Wiley - VCH, 2007.
17. Parag Diwan and Ashish Bharadwaj, Nano Medicines, Pentagon Press, 2006.
18. Nancy A. Monteiro - Riviere and C. Lang Tran, Nanotoxicology, Characterization, Dosing and Health Effects, Informa Healthcare, 2007.
19. Kumar, Challa S. S. R., Nanomaterials - Toxicity, Health and Environmental Issues, Wiley - VCH, Weinheim, 2006.

ELECTIVE-2: INDUSTRIAL CHEMISTRY

SEMESTER V&VI	SUBJECT CODE:	ELECTIVE	MARKS 100	CREDITS 5	HOURS 75

Objectives:

To have the thorough knowledge on various chemical industries and their manufacturing processes.

UNIT - 1: Industrial Requirements (15 hrs)

Requirements of an industry - location - water - industrial water treatment - safety measures - pilot plants. Fuels - types of fuels with examples - coal - carbonization of coal - coal far distillation - liquid fuels - gaseous fuels - selection of fuels - nuclear fuels. Energy - sources of energy - renewable and non - renewable energies - non conventional energies.Industrial catalysts - Types of catalysts - Functions and applications of Raney Nickel, Pd, $CuCrO_4$, TiO_2, Al, V and Pt based catalysts and zeolites.

UNIT - 2: Petrochemical Industries (15 hrs)

Crude oil - constitution and distillation - composition of different distillates - pour points, depressants, drag reducers, viscosity reducers, ignition point, flash point octane number - cracking - catalysts used in petroleum industries - strucutre, selectivty and applications. Manufacture of synthetic petrol - Dergius and Fischer Tropsh processes - Manufacture of petrochemicals and petrochemical polymers - Manufacture of higher olefins, Acetaldehyde, Acetic acid, Ethylene glycol, Glycerine, Acetone, Phenol, Carbon disulphide, Vinylacctate, Cumene, Chlorophrene, Butane diols, Xylenes.

UNIT - 3: Fertilizers and Speciality Chemicals (15 hrs)

Manufacture - Properties and industrial uses of solvents - DMF, DMSO, THF and Diozane. Fertilizers - Raw materials, manufacture (flow chart chemical process with equations) of ammonium nitrate, ammonium sulphate, urea, calcium cyanamide, calcium ammonium nitrate, sodium nitrate, ammonium chloride, ammonium phosphate, super phosphate of lime, NPK fertilizers, Manufacture in pure form of the following - Sodium carbonate, Oxalic acid, Potassium dichromate, Perchloric acid.

UNIT - 4: Oils, Soaps and Detergents (15 hrs)

Manufacture of Cl_2, NaOH and Chlorates of Na and K - manufacture of perchlorate. Oils - difference between oils and fats - manufacture of cotton seed oil and soybean oil - refining of oil - manufacture of soaps - toilet and transparent soaps - Detergents - synthetic detergents - surface active agents and their classification - manufacture of anionic, cationic and non ionic detergents and shampoo.

Sugar industry - manufacture of sugar from cane sugar and beet root. Manufacture of leather - hides - Vegetable and chrome tanning finishing. Manufacture of dinitrophenols, malathion, parathion, schradan and dementon.

UNIT - 5: Metallurgy **(15 hrs)**

General methods of metallurgy - ores - types - methods of concentration of ores - hydro metallurgy, phyrometallurgy - various reduction process, refining of metals - extraction of Cr, Mn, V, Co, Pt, U and Th. Environmental problems of chemicals industries - methods of control - sewage treatment and waste management.

REFERENCEBOOKS

1. B.K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut,2003
2. C. E.Drydense, Outlines of Chemical Technology, Gopala Rao, Eastwest Press, New Delhi, third edition, 1997.
3. G.T. Austin, R.N. Shreve, Chemical Process Industries, Tata McGraw Hill publishing company, Mumbai, fifth edition, 1984.
4. H. Steines, Introduction to Petrochemicals, Pergaman Press, 1961.
5. Alan Cottrel, An Introduction to Metallurgy, Orient Longman, 2000.

ELECTIVE-3: PHARMACEUTICAL CHEMISTRY

SEMESTER V&VI	SUBJECT CODE:	ELECTIVE	MARKS 100	CREDITS 5	HOURS 75

Objectives:

- *To understand the pharmacology, drugs and their mechanism of action, various diseases and their cure.*
- *To introduce the knowledge on pharmaceutical industries and their functioning.*

UNIT - 1: Introduction (15 hrs)

Common diseases – Infective diseases – insect - born, air - born and water - born – hereditary diseases. Terminology of drugs, pharmacology, pharmacognesy, pharmacodynamics, pharmacokinetics, antimetabolites. Indian medicinal plants – Tulsi, Neem, Keezhanelli and their importance.

UNIT - 2: Drugs (15 hrs)

Mechanism of drug action – Action at cellular and extra cellular sites. Absorption of drugs – routes of administration , factors affecting absorption – Assay of drugs – chemical, biological, immunological assays, LD_{50} and ED_{50}, therapeutic index, drug dosage. Metabolism of drugs through oxidation, reduction, hydrolysis and conjugate processes; factors affecting metabolism.

UNIT - 3: Chemotherapy (15 hrs)

Definition and two examples each: Anaesthetics – General and local; Analgesics – Narcotic and synthetic; Antipyretics and anti inflammatory agents. Antibiotics: penicillin, streptomycin, chloramphenicol and tetracyclins – Antivirals, AIDS: symptoms, prevention, treatment – Cancer and neoplastic agents.

UNIT - 4: Common Body Ailments (15 hrs)

Diabetes – Causes, hyper and hypoglycemic drugs – Blood pressure – Systolic and Diastolic, Hypertensive drugs – cardiovascular drugs – antiarrhythmic, antianginals, vasodialators – Psychedelic drugs, hypnotics, sedatives – Lipid profile – HDL, LDL cholesterol, lipid lowering drugs. Composition of Blood: Blood grouping and Matching – Role of blood as Oxygen carrier, Coagulation of Blood - Coagulants, Anticoagulants. Anaemia – Causes and control.

UNIT - 5: Pharma Industries: Functioning and Documentations (15 hrs)

Introduction of pharma industry - research and development unit - process development and batch manufacturing - quality control and quality assurance – specifications - Standard Operating Procedures (SOP) – Standard Testing Procedures (STP) – Material

safety data sheets– journals – pharmacopeia – patents (product and process) – reports and records. Regulatory affairs for pharma industries like GLP, GMP, ISO, and FDA.

REFERENCE BOOKS

1. Jayashree Ghosh, Pharmaceutical Chemistry, S. Chand and Company Ltd., New Delhi, first edition, 2006,
2. S. Lakshmi, Pharmaceutical Chemistry S. Chand & Sons New Delhi, third edition, 1995.
3. Ashutosh Kar, Medicinal Chemistry, New Age International Ltd., New Delhi, 1993.
4. Divid A. William, Thomas Lemke, O. Foyes, Principles of Medicinal Chemistry, Bl publishers, fifth Edition, 2005.
5. Bertram G. Katzung, Basic & Clinical Pharmacology, McGraw-Hill Medical, twelth edition, 2012.
6. E. Prichard, Quality in the Analytical Chemistry Laboratory, John Wiley and sons NewYork, 1997.
7. W Funk, V Dammann, G. Donnevert, Quality Assurance in Analytical, VCH Weinheim, New York, 1995.

ELECTIVE-4: APPLIED ELECTROCHEMISTRY

SEMESTER V&VI	SUBJECT CODE:	ELECTIVE	MARKS 100	CREDITS 5	HOURS 75

Objectives:

To know the applications of electrochemistry in industrial processes viz., metallurgy, coating, cells and corrosion.

UNIT - 1: Industrial Electrochemistry (15 hrs)

Electrochemical process in industry - components of electrochemical reactions - Types of electrolytes - Cathodes and anodes in electrochemical reactor - separators. Inorganic Electrochemicals: Caustic soda and chlorine production, mercury cells, diaphragm cells, membrane cells - Advantage chlorates, perchlorates, hydrogen peroxide. Organic Electrochemicals: Special feature of electro-organic synthesis - electro chemical oxidation. Kolbe synthesis - electro reduction of carbonyl compounds - adiponitrile synthesis.

UNIT - 2: Electrometallurgy (15 hrs)

Electro deposition of metals - principles - nucleation and growth of crystals - nature of electro deposits. Hydrometallurgy: Recovery of meals. Recovery of silver from photographic emulsion - electro refining - production of high copper; process description. Pyro-metallurgy: Necessity for using molten electrolytes - reactors for molten salt electrolytes - Production of aluminium - electrodes and electrode reactions in cryolite melt. Electrochemical purification of aluminium - other metals through molten salt electrolysis - Magnesium and sodium brief outline.

UNTI 3 :Electroplating (15 hrs)

Fundamental principles - nature of deposits for electroplating - Hull cell experiments - operating conditions and nature of deposits - throwing power - preparation of samples for electroplating - chemical and electrochemical cleaning - electroplating of copper, nickel and cadmium. Electroless plating: Importance, plating of non-metals - both composition - electroless plating of copper and nickel.

UNIT - 4: Electrochemical Power Sources (15 hrs)

Basic principles, chemical and electrical energies - inter conversion - changing and discharging - requirements for a good power source - Types of power sources. Primary Batteries: Description of primary cells - alkaline, manganese cells - silver oxide - zinc cells - lithium primary cells - applications. Secondary Batteries: Importance applications - charge discharge efficiency - cycle life - energy density - lead acid batteries for electric vehicles. Fuel Cells: Basic principles - Hydrogen, oxygen fuel cells - gas diffusion electrodes for fuel cells - alkaline fuel cells.

UNIT - 5: Corrosion and Prevention (15 hrs)

Principles - stability of metals - EMF series - active and noble metals. pH effect of stability - Pourbaix diagram - Kinetics of corrosion - mixed potential process - cathodic reaction - anodic reaction - corrosion current - active dissolution - passivation - break down of passivity - Evans diagram. Method of corrosion protection. Principles and inhibition of anodic, cathodic processes - Inhibitive additives for corrosion protection - protective coatings - types of coatings - protection of structures and pipelines - cathodic protection - examples - sacrificial anodes - protection of ships in sea water.

REFERENCE BOOKS:

1. D. Pletcher and F.C. Waish, Industrial Chemistry, second edition, 1990.
2. C.H. Hamann, A. Hamnett and W. Vielstich, Electrochemistry, Weinheim-Wiely VCH,1998.
3. D.B. Hibbert, Introduction to Electrochemistry, McMillan, London, 1993.

ELECTIVE - 5: POLYMER CHEMISTRY

SEMESTER V&VI	SUBJECT CODE:	ELECTIVE	MARKS 100	CREDITS 5	HOURS 75

Objectives:

To develop the knowledge on chemistry of polymers and their applications.

UNIT - 1: Introduction to Polymers (15 hrs)

Importance of polymers: Basic concept - Monomers and polymers - definition. Classification of polymers on the basis of microstrucutres, macrostructures and applications (thermosetting and thermoplastics). Distinction among plastics, elastomers and fibers. Homo and hetero polymers and copolymers.

Chemistry of polymerization: Chain polymerisation, free radical, ionic, coordination and step polymerisation. Polyaddition and polycondensation - miscellaneous ring - opening and group transfer polymerisations.

UNIT - 2: Physical Properties and Reactions of Polymers (15 hrs)

Properties: Glass transition temperature (Tg) - Definition - Factors affecting Tg - relationships between Tg and molecular weight and melting point. Importance of Tg. Molecular weight of polymers: Number average, weight average, sedimentation and viscosity average molecular weights. Molecular weights and degree of polymerisation. Reactions: hydrolysis - hydrogenation - addition - substitutions - cross-linking, vulcanisation and cyclisations reactions. Polymer degradation: Basic idea of thermal, photo and oxidative degradations of polymers.

UNIT - 3: Polymerization Techniques and Processing (15 hrs)

Polymerisation techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations. Polymer processing: Calendering - die casting, rotational casting - compression. Injection moulding.

UNIT - 4: Chemistry of Commercial Polymers (15 hrs)

General methods of preparation, properties and uses of the following: Teflon, polymethylmethacrylate. Polythylene, polystyrene, PAN, polyesters, polycarbonates, polyamides (Kevlar), polyurethanes, PVC, epoxy resins, rubber - styrene and neoprene rubbers, Phenol-formaldehydes and urea - formaldehyde resins.

UNIT - 5: Advances in Polymers (15 hrs)

Biopolymers – biomaterials; polymers in medical field. High temperature and fire - resistant polymers – Silicones - carbon Fibers (Basic idea only).

TEXT BOOK

1. F.W. Billmeyer, Text book of Polymer Science, Jr. John Wiley & Sons, 1984.

REFERENCE BOOKS:

1. V.R. Gowariker, N.V. Viswanathan and Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi, 1978.
2. B.K. Sharma, Polymer Chemistry, Goel Publishing House, Meerut, 1989.
3. M.G. Arora, and M.S. Yadav, Polymer Chemistry, Anmol Publications Private Ltd., New Delhi, second revised edition,1989.

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ALLIED CHEMISTRY

(For B.Sc., Physics,

Mathematics,

Plant Biology & Plant Biotechnology

and

Advance Zoology & Biotechnology)

SYLLABUS FOR ALLIED CHEMISTRY

ALLIED CHEMISTRY - I
(For Mathematics & Physics Students)

SEMESTER	SUBJECT	THEORY	CREDIT	HOURS
I	CODE:		3	45

UNIT – 1: Chemical Bonding and Nuclear Chemistry

Chemical Bonding**:** Molecular Orbital Theory-bonding, antibonding and nonbonding orbitals. Molecular orbital diagrams for Hydrogen, Helium, Nitrogen; discussion of bond order and magnetic properties.

Nuclear Chemistry: Fundamental particles - Isotopes, Isobars, Isotones and Isomers- Differences between chemical reactions and nuclear reactions - group displacement law. Nuclear binding energy - mass defect - calculations. Nuclear fission and nuclear fusion - differences – Stellar energy. Applications of radioisotopes - carbon dating, rock dating and medicinal applications.

UNIT – 2: Industrial Chemistry

Fuels: Fuel gases: Natural gas, water gas, semiwater gas, carbureted water gas, producer gas, CNG, LPG and oil gas (manufacturing details not required). Silicones**:** Synthesis, properties and uses of silicones.

Fertilizers: Urea, ammonium sulphate, potassium nitrate, NPK fertilizer, super phosphate, triple superphosphate.

UNIT – 3: Fundamental Concepts in Organic Chemistry

Hybridization: Orbital overlap, hybridization and geometry of CH_4, C_2H_4, C_2H_2 and C_6H_6.

Electronic effects: Inductive effect and consequences on K_a and K_b of organic acids and bases, electromeric , mesomeric, hyperconjugation and steric- examples and explanation.

Reaction mechanisms: Types of reactions - aromaticity- aromatic electrophilic substitution; nitration, halogenation, Friedel - Craft's alkylation and acylation.

Heterocyclic compounds: Preparation, properties of pyrrole and pyridine.

UNIT - 4: Thermodynamics and Phase Equilibria

Thermodynamics: Types of systems, reversible and irreversible processes, isothermal and adiabatic processes and spontaneous processes. Statements of first law and second law of thermodynamics. Carnot's cycle and efficiency of heat engine. Entropy and its significance. Free energy change and its importance (no derivation). Conditions for spontaneity in terms of entropy and Gibbs free energy. Relationship between Gibbs free energy and entropy.

Phase Equilibria**:** Phase rule - definition of terms in it. Applications of phase rule to water system. Two component system - Reduced phase rule and its application to a simple eutectic system (Pb-Ag).

UNIT – 5: Analytical Chemistry

Introduction to qualitative and quantitative analysis. Principles of volumetric analysis. Separation and purification techniques – extraction, distillation and crystallization.

Chromatography: principle and application of column, paper and thin layer chromatography.

REFERENCE BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.
3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
5. P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007.
6. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty fourth edition, 2010.
7. B. K, Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.

ALLIED CHEMISTRY - II

SEMESTER II	SUBJECT CODE:	THEORY	CREDIT 3	HOURS 45

UNIT – 1: Co-ordination Chemistry and Water Technology

Co-ordination Chemistry: Definition of terms - IUPAC Nomenclature - Werner's theory - EAN rule - Pauling's theory – Postulates - Applications to $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Co(CN)_6]^{3-}$ Chelation - Biological role of Haemoglobin and Chlorophyll (elementary idea) - Applications in qualitative and quantitative analysis.

Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method - Purification techniques - BOD, COD.

UNIT – 2: Carbohydrates and Amino acids

Carbohydrates: Classification, preparation and properties of glucose, fructose and sucrose. Discussion of open chain ring structures of glucose and fructose. Glucose –fructose interconversion. Properties of starch and cellulose.

Amino acids: Classification - preparation and properties of alanine, preparation of dipeptides using Bergmann method. RNA and DNA (elementary idea only).

UNIT – 3: Electrochemistry

Galvanic cells - Standard hydrogen electrode - calomel electrode - standard electrode potentials - electrochemical series. Strong and weak electrolytes - ionic product of water - pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method - buffer solutions and its biological applications - electroplating - Nickel and chrome plating - Types of cells - fuel cells - corrosion and its prevention.

UNIT – 4: Kinetics and Catalysis

Order and molecularity. Integrated rate expression for I and II (2A → Products) order reactions. Pseudo first order reaction, methods of determining order of a reaction - Half life period – Catalysis - homogeneous and heterogeneous, catalyst used in Contact and Haber's processes. Concept of energy of activation and Arrhenius equation.

UNIT – 5: Photochemistry

Grothus-Drapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield - Hydrogen-chloride reaction. Phosphorescence, fluorescence, chemiluminescence and photosensitization and photosynthesis (definition with examples).

REFERENCE BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.

2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.
3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
5. P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007.
6. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty fourth edition, 2010.
7. B. K, Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.

ALLIED CHEMISTRY - I
(For Botany and Zoology Students)

SEMESTER I	SUBJECT CODE:	THEORY	CREDIT 3	HOURS 45

UNIT – 1: Chemical Bonding and Nuclear Chemistry

Chemical Bonding: Molecular Orbital Theory-bonding, antibonding and nonbonding orbitals. M. O diagrams for Hydrogen, Helium, Nitrogen; discussion of bond order and magnetic properties.

Nuclear Chemistry: Fundamental particles - Isotopes, Isobars, Isotones and Isomers- Differences between chemical reactions and nuclear reactions - group displacement law. Nuclear binding energy - mass defect - calculations. Nuclear fission and nuclear fusion - differences – Stellar energy. Applications of radioisotopes - carbon dating, rock dating and medicinal applications.

UNIT – 2: Industrial Chemistry

Fuels: Fuel gases: Natural gas, water gas, semiwater gas, carbureted water gas, producer gas, CNG, LPG and oil gas (manufacturing details not required).

Silicones: Synthesis, properties and uses of silicones.

Fertilizers: Urea, ammonium sulphate, potassium nitrate NPK fertilizer, super phosphate, triple superphosphate.

UNIT – 3: Fundamental Concepts in Organic Chemistry

Hybridization: Orbital overlap hybridization and geometry of CH_4, C_2H_4, C_2H_2 and C_6H_6.

Polar effects: Inductive effect and consequences on K_a and K_b of organic acids and bases, electromeric , mesomeric, hyperconjugation and steric- examples and explanation.

Reaction mechanisms: Types of reactions - aromaticity- aromatic electrophilic substitution; nitration, halogenation, Friedel - Craft's alkylation and acylation.

Heterocyclic compounds: Preparation, properties of pyrrole and pyridine.

UNIT – 5: Useful Organic compounds

Definition, structure and uses: Antibiotics viz., Penicillin, Chloramphenicol and Streptomycin; Anaesthetics viz., Chloroform and ether; Antipyretics viz., aspirin, paracetamol and ibuprofen; Artificial sugar viz., saccharin, Aspartame and cyclamate; Organic Halogen compounds viz., Freon, Teflon.

UNIT – 5: Analytical Chemistry

Introduction qualitative and quantitative analysis. Principles of volumetric analysis. Separation and purification techniques: extraction, distillation and crystallization.
Chromatography: principle and application of column, paper and thin layer chromatography.

REFERENCE BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.
3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
5. P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007.
6. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty fourth edition, 2010.
7. B. K, Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.
8. Jayashree gosh, Fundamental Concepts of Applied Chemistry; Sulan & Chand, Edition – 2006.

ALLIED CHEMISTRY - II
(For Botany and Zoology Students)

SEMESTER II	SUBJECT CODE:	THEORY	CREDIT 3	HOURS 45

UNIT – 1: Co-ordination Chemistry and Water Technology

Co-ordination Chemistry**:** Definition of terms - IUPAC Nomenclature - Werner's theory - EAN rule - Pauling's theory – Postulates - Applications to $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Co(CN)_6]^{3-}$ Chelation - Biological role of Haemoglobin and Chlorophyll (elementary idea) - Applications in qualitative and quantitative analysis.

Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method - Purification techniques – BOD and COD.

UNIT – 2: Carbohydrates

Classification, preparation and properties of glucose and fructose. Discussion of open chain ring structures of glucose and fructose. Glucose-fructose interconversion. Preparation and properties of sucrose, starch and cellulose.

UNIT – 3: Amino Acids and Essential elements of biosystem

Classification - preparation and properties of alanine, preparation of dipeptides using Bergmann method - Proteins-classification – structure - Colour reactions - Biological functions –nucleosides - nucleotides - RNA and DNA – structure. Essentials of trace metals in biological system- Na, Cu, K, Zn, Fe, Mg.

UNIT – 4: Electrochemistry

Galvanic cells - Standard hydrogen electrode - calomel electrode - standard electrode potentials - electrochemical series. Strong and weak electrolytes - ionic product of water - pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method - buffer solutions and its biological applications - electroplating - Nickel and chrome plating - Types of cells - fuel cells - corrosion and its prevention.

UNIT – 5: Photochemistry

Grothus-Drapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield - Hydrogen-chloride reaction. Phosphorescence, fluorescence, chemiluminescence and photosensitization and photosynthesis (definition with examples).

REFERENCE BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.

3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
5. P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007.
6. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty fourth edition, 2010.
7. B. K, Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.

ALLIED CHEMISTRY PRACTICAL
(Common for Mathematics, Physics, Botany and Zoology students)

SEMESTER I & II	SUBJECT CODE:	PRACTICAL	CREDIT 4	HOURS 60

1. VOLUMETRIC ANALYSIS

1. Estimation of Sodium hydroxide using standard Sodium Carbonate.
2. Estimation of Hydrochloric acid using standard Oxalic acid.
3. Estimation of Ferrous sulphate using standard Mohr's salt
4. Estimation oxalic acid using standard Ferrous Sulphate.
5. Estimation of Potassium permanganate using standard Sodium hydroxide.
6. Estimation of Magnesium using EDTA.
7. Estimation of Ferrous ion using diphenylamine as internal indicator.

2. SYSTEMATIC ANALYSIS OF ORGANIC COMPOUNDS

The analysis must be carried out as follows:

a) Functional group tests [phenol, acids (mono & di) aromatic primary amine, amides (mono & di), aldehyde and glucose].
b) Detection of elements (N, S, Halogens)
c) Distinguish between aliphatic and aromatic
d) Saturated and unsaturated compounds.

REFERENCE BOOK:

V. Venkateswaran, R. Veerasamy, A. R. Kulandaivelu, Basic Principles of Practical Chemistry; Sultan Chand & sons, second edition, 1997.